PCC Pavement Preservation

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April 19, 2005

PPTG 2005 Forum

Why Preserve PCC Pavement?

- PCC Pavements are Durable
  - Most in service since 1952 to 1975 have had minimal repairs
- PCC Pavements are Cost Effective
  - Initial cost $50 to $100 per lane foot, about $270,000 to $530,000 per lane mile
  - 50+ year life, with few distresses
  - 60% Lower Life-Cycle Costs than other options

Why Preserve PCC Pavements?

- PCC Pavement Repairs are Durable
  - Slab replacements with early opening strength above 400 PSI, in service since 1997
  - Dowel Bar Retrofit, in service since 1998
  - Spall Repair, with polyester concrete, in service since 1987
- Durable Repairs Require Less Maintenance, and Lower Life-Cycle Costs

PCC Environmental Benefits

- Portland Cement is Manufactured with Whole Scrap Tires
  - The whole scrap tire, belts and all, including UV damaged tires from landfills
  - A tire feeds into the kiln every 5 seconds, for fuel and mineralogy
  - Whole tire tonnage in Cement production exceeds all scrap rubber use in the U.S.

PCC Environmental Benefits

- PCC Pavement Maintains Lower Surface Temperature During Hot Weather
  - Lesser impact local energy use to cool the environment and on global warming
- Noise Reduction from Grinding
  - Typically a 5 dB reduction in pavement noise
  - Reduction is long lasting, when combined with DBR to prevent faulting

How Do We Preserve PCC Pavements?

- Understand the Causes of PCC Distress
- Understand the Corrective Measures to Preserve PCC Pavements
- Understand the Difference Between Initial Cost and Life-Cycle Cost
- Be Committed to More Durable Methods that Result in Lower Life-Cycle Costs

Distresses of PCC Pavements

- Faulting
  - Untreated base and shoulder erosion
  - Impact loading, slab and corner cracks
- Fatigue Cracking
  - Mid-panel cracks
- Spalling
- Surface Polish
  - Low skid resistance

Faulting

Faulting Mechanisms

- Loss of Load Transfer at Transverse Joints
  - Aggregate interlock wears down (over time) and allows pumping to occur
- Erosion of Untreated Bases & Shoulder
  - Pumping causes erosion of untreated base materials, shifting base particles, and loss of slab support
- Noticeable Slab Drop-Off Appears

more...

Pumping in Action

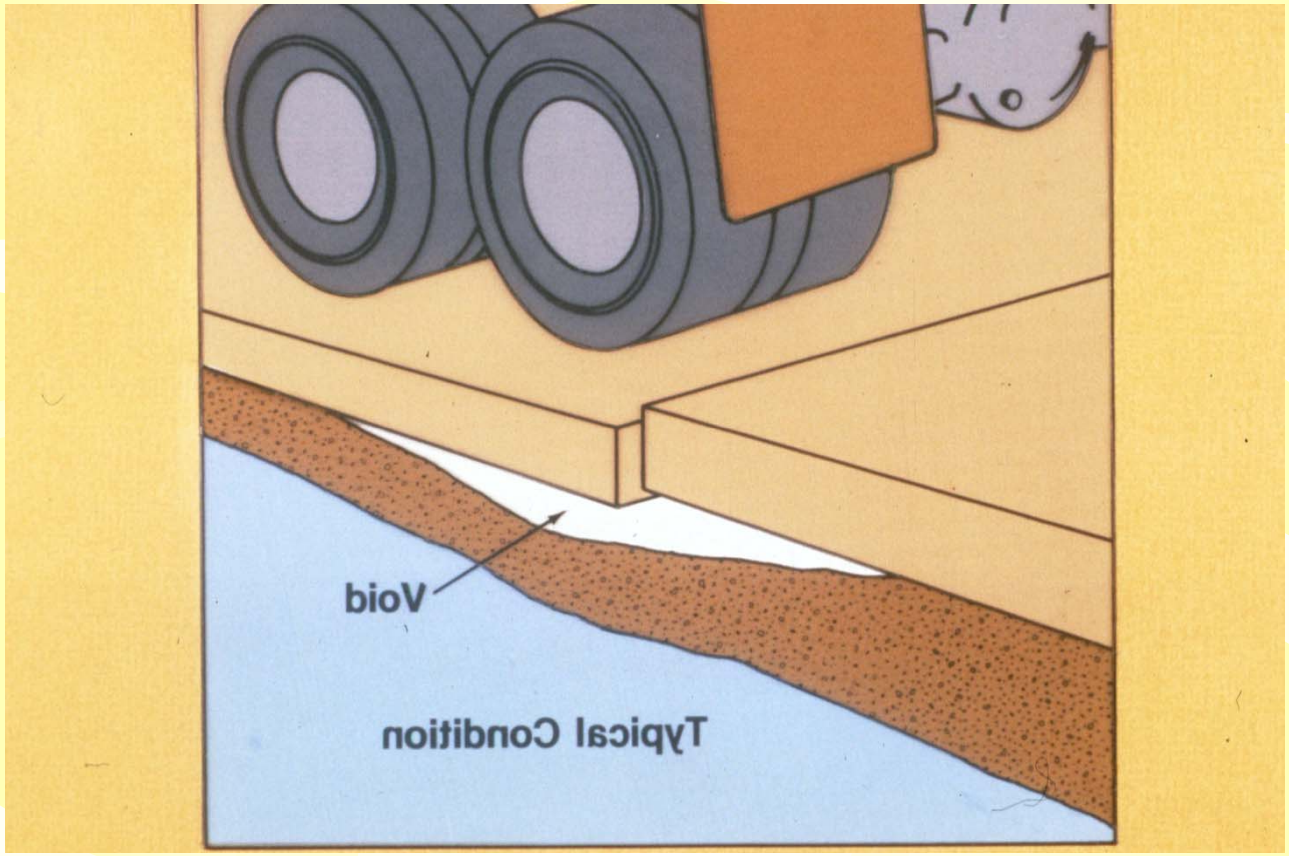
Evidence of Pumping, Shoulder Erosion

Faulting Mechanisms, continued

- Impact Loading Occurs as Vehicles Drop-Off onto the Adjacent Slab
  - Especially heavy, fast-moving trucks, busses
- Slab Cracking and Corner Breaks Appear
  - Loss of fines from pumping combined with impact loading breaks up the slab

If allowed to continue, more expensive rehabilitation strategies are required...

Slab Drop-Off, Base Erosion



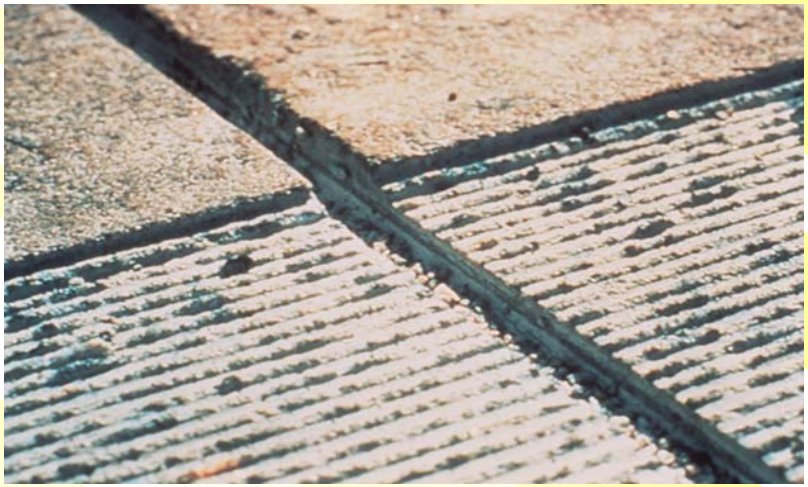
Cracking from Base Erosion

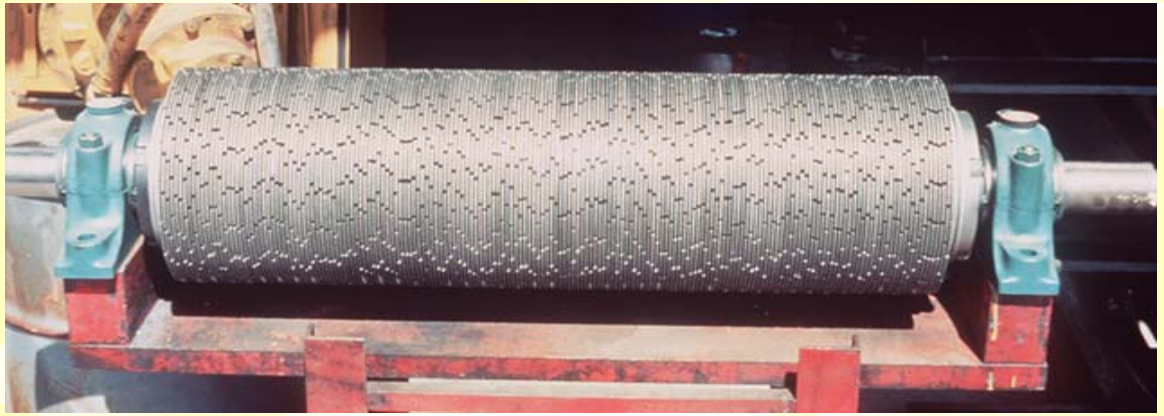
Severe Pumping, Third-Stage Cracking

Faulting Corrective Measures

- Surface Grind
  - Eliminates slab drop-off, temporarily (5 years)
- Restore Load Transfer and Grind
  - Dowel Bar Retrofit with grind prevents drop-off from reoccurring (15+ years, so far)
- Shoulder Replacement
  - Eliminates a primary source of fine particles, when matching treated base layers are used

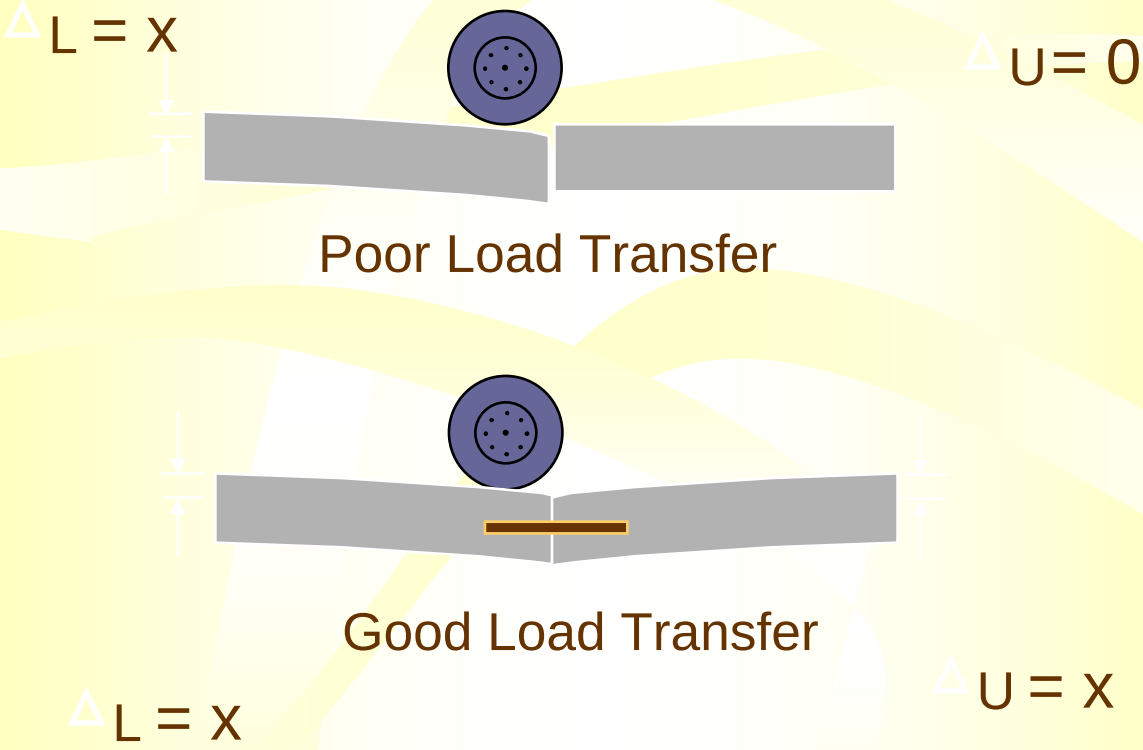
Grinding





Dowel Bar Retrofit, During & After

How Load Transfer Works

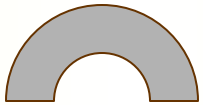


Faulting Corrective Measures, continued

- Subseal with Flowable Cementitious Grout
  - Fills under slab voids to restore slab support
  - CAUTION: Do not attempt to level slab! It causes damaging tensile stress cracking!
- Seal Joints
  - Reduces aerially deposited fines if sealant fully adheres to the joint walls
  - Can reduce trapped debris which cause spalling

Fatigue Cracking

Fatigue Cracking Mechanisms

- Environmental Slab Curl
  - Slabs curl up  when surface is cool
  - Slabs curl down  when surface is warm
- Repeated Slab Curl
  - Joint movement causes loss of load transfer
  - Causes fatigue cracking, a mid-slab transverse crack, aka “first-stage cracking”
  - May cause “second-” & “third-stage cracking”

Fatigue Cracking Corrective Measures

- Shorten Slab Length between 6’ to 15’
  - Lowers tensile loads, reduces curl
- Dowel Bar Retrofit
  - Reduces curl through increased load transfer
  - Repair mid-slab cracks, first-stage cracking
- Slab Replacement
  - Usually for second- and third-stage cracking
  - Low thermal co-efficient mixes reduce curl

Slab Replacement with Dowel Baskets

Spalling

Spalling Mechanisms

- Slabs Expand and Contract
  - Thermal expansion and contraction opens joints in cool weather, closes them in warm weather
- Incompressible Debris Trapped in the Joint
  - As joints open, debris such as nails, nuts, bolts, screws, rocks, etc., become trapped
  - As joints close, trapped debris causes fractures of the concrete, enlarging the joints

Spalling Mechanisms, continued

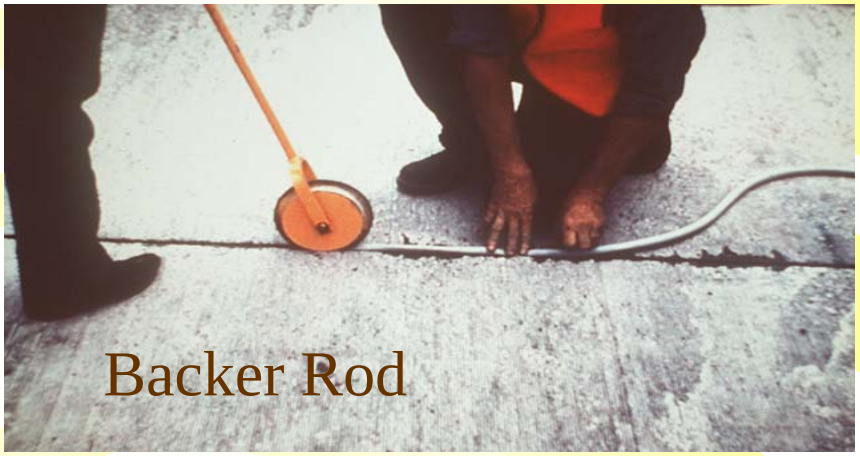
- Damaged Joints Allow Larger Debris
  - Larger debris cause larger fractures, more visible spalling
- Other Causes (during construction)
  - sawing too late causes volunteer cracking
  - sawing too early causes joint ravelling
  - insert method instead of sawing can cause a joint that breaks off at a 45° angle

Spalling Corrective Measures

- Before Spalling Occurs
  - Seal joints, prefer neoprene compression seal
  - Silicon adhesion is poor due to dust in joint
  - Asphaltic sealant attracts and holds debris
- After Spalling Occurs
  - Remove damaged area, rout and clean joints
  - Spall repair with polyester concrete
  - Seal joints

Joint Preparation

Sand Blasting to Rout Debris

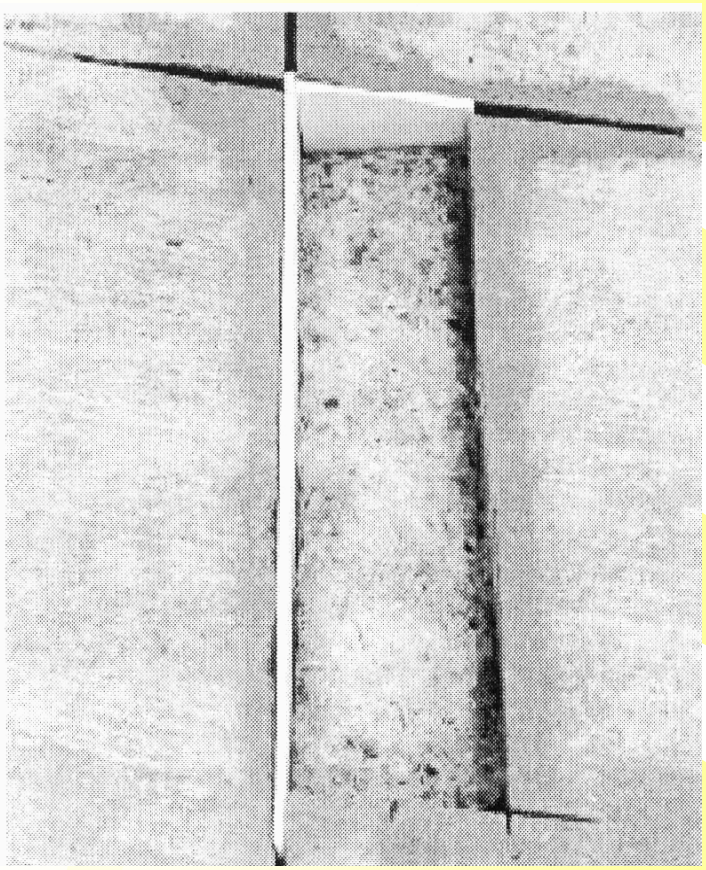


Backer Rod

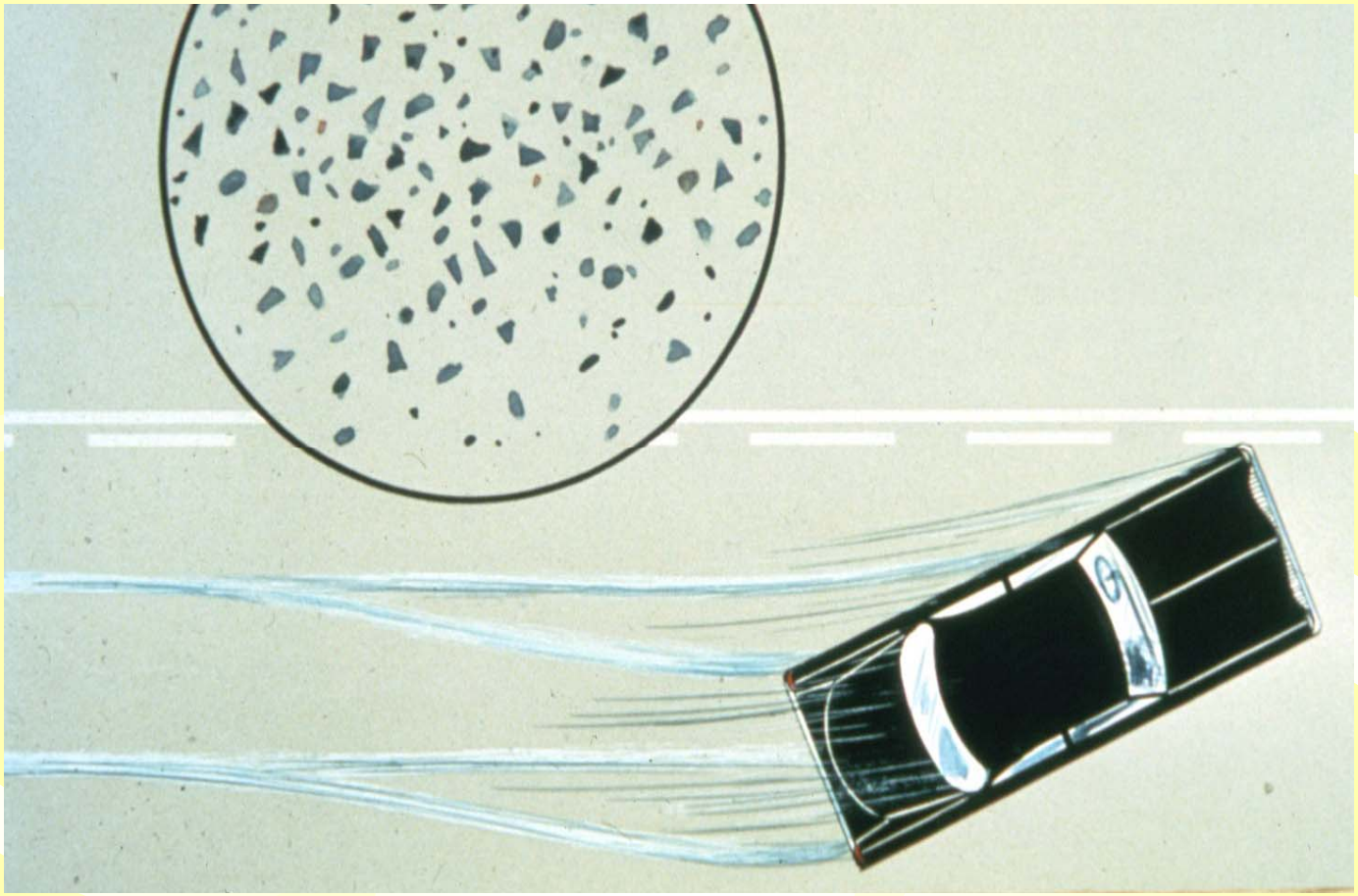
Cold Applied Sealant

Neoprene Compression Seal

Spall Repair Preparation



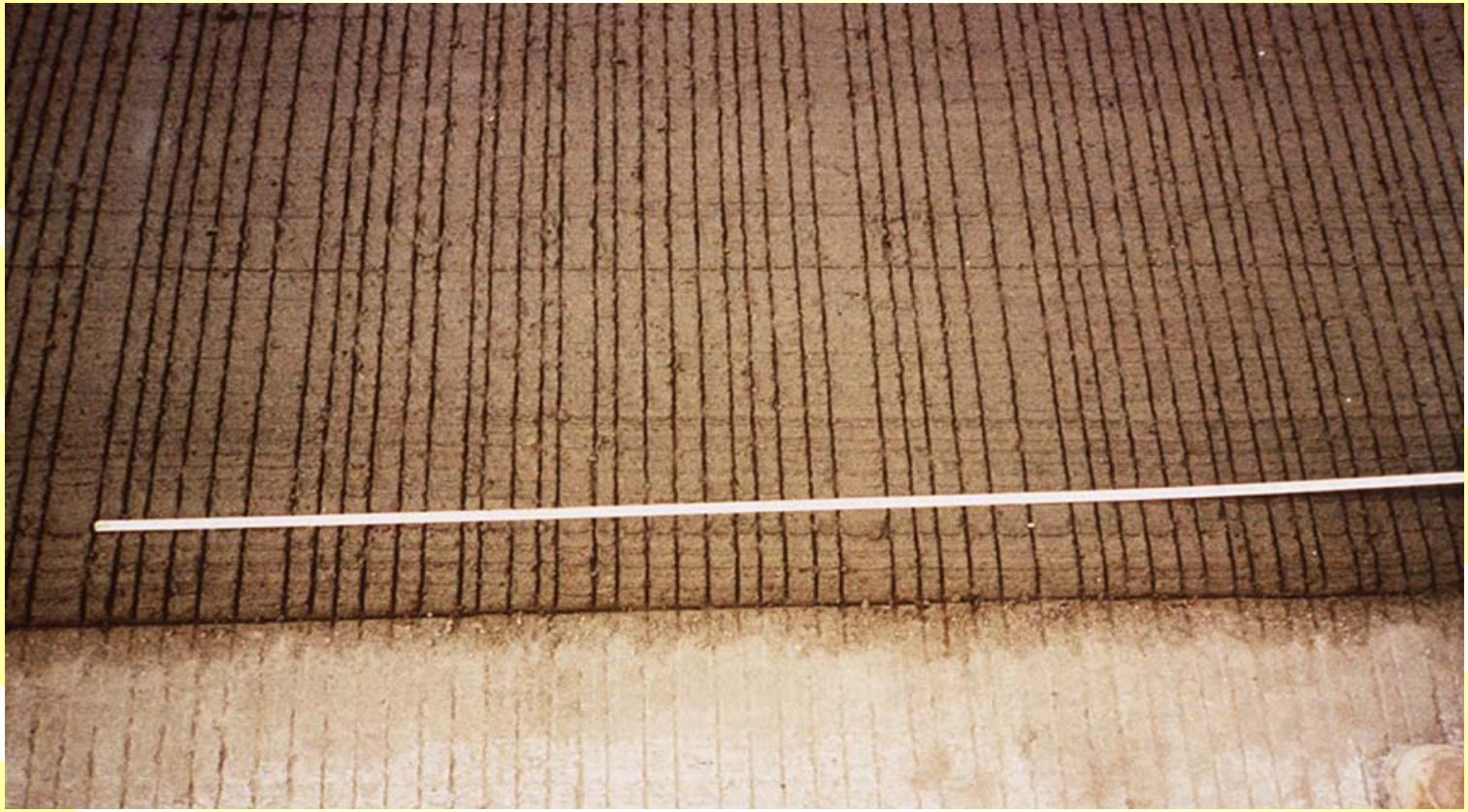
Surface Polish



Surface Polish Mechanisms

- Tire Action Wears Off Surface Texture
- Poor Construction Practices Result in Early Surface Polish
  - Excessive cement paste wears off sooner
  - “Tempering” with water causes paste with high W/C (water/cement) ratio, low surface strength (also the cause of scaling in freeze/thaw areas)
  - Highly polished aggregate in mix

Original Surface Texture



Surface Polish Corrective Measures

- Grinding
  - Restores surface texture, skid resistance
- Grooving
  - Restores surface texture, skid resistance
  - CAUTION: Do not groove a previously grooved surface! Results in broken “fins”!

Always Groove and Grind in the longitudinal direction to reduce tire noise!

Summary

PCC Pavement:

- Cost Effective and Durable
- Environmentally Friendly
- Few Types of Failures

PCC Preservation Strategies:

- Simple and Cost Effective
- Mitigates More Costly Impacts

Frequently Asked Questions

- How do you determine loss of load transfer?
  - Faulting is a reliable predictor
  - Falling Weight Deflection (FWD) Testing confirms percent loss of load transfer
- Why is a treated base required under PCC?
  - A treated base does limits untreated fines that cause erosion and loss of slab support

More FAQs

- What other ways help prevent Faulting
  - Limit the sources of fines, untreated shoulders and aerially deposited fines entering the joints
- Why replace slabs with RSC and not PCC?
  - If opening time within 10 days is acceptable, then PCC can be used
  - RSC is used when early opening within a few hours is critical.

More FAQs

- Why use RSC instead of calcium chloride?
  - RSC gains strength rapidly, 400 PSI in 4 hours; whereas calcium chloride has less than 80 PSI
  - Calcium chloride has excessive shrinkage and corrosive properties that make it a poor choice